

II. *On Callophrys avis*, *Chpm.* By T. A. CHAPMAN,
M.D., F.Z.S.

[Read November 17th, 1909.]

PLATES XIV—XLIII.

IT is a remarkable circumstance that this very interesting and pretty butterfly should have remained quite unknown until so late a date as this, a species somewhat widely distributed, occurring in France, Spain, Portugal, Morocco (probably Algeria)* and Tunis. It is not a matter of distinguishing or establishing a species previously confounded with another or regarded as a mere variety, but a species of which so far as I have been able to ascertain, only some half-dozen specimens, beyond my own captures, exist in collections, and of these, three, I think, were captured in the present year. The species, as observed by me, is extremely localised in each habitat, and this is no doubt true throughout its whole distribution.

One circumstance about the specimens of *C. avis* that I have ascertained to exist in collections is somewhat striking, that is, that they all or nearly all are solitary specimens, each from a different locality. My two Hyères specimens were taken in two different years at two different places. Then there is one from Tangier in the British Museum, one taken by Prof. Reverdin on the Riviera, one taken by Mr. Rowntree at Bussaco, one by Prof. Tavares at Jerez, and M. Oberthür's specimens (two, not one) from Tunisia. But that my curiosity about the insect had been aroused, there would probably have been a further *one* from Amélie-les-Bains.

The explanation is, I think, simple. Most collectors more or less ignore *C. rubi* as beneath their notice, perhaps pick up half-a-dozen. *C. rubi* has habitats by the square mile. The habitats of *C. avis* may usually, I imagine, be measured by acres, or even yards. In picking up his half-dozen *C. rubi*, he may happen to pick up an odd specimen of *C. avis*, but before he captures another,

* Under date November 24th, M. Oberthür tells me that Mr. H. Powell took two ♂s at Khenchela (Province of Constantine).

he has quite left the *C. avis* habitat, and that odd one is all he has. With no clue but my first capture and thinking it was possibly an aberration of *C. rubi*, I failed to recognise the habitat though I knew approximately where it was, and in my second year's search, picked up another in quite another spot, which unfortunately did not make me work this second locality, but rather, at the time, confirmed the idea that it was a sporadic aberration. Not perhaps an unnatural result, as those were the only two known specimens.

An account of *C. avis* involves at many points a comparison with *C. rubi*, and it will be found that the following notes deal largely with *C. rubi*. I have been somewhat struck, however, by the circumstance that many of the details as to *C. rubi* with which I have to deal, are more or less new, and, at any rate, have not been dealt with adequately, if at all, in any British medium.

The original description of *Callophrys avis* is as follows (from "Ent. Record," vol. xxi, p. 130)—

"Much resembles *Callophrys rubi*. *C. avis* is larger, 32 mm. to 36 mm. in expanse; *C. rubi* rarely exceeds 32 mm. It has hardly any trace of tails. The upper surface has a ruddy tint, in excess usually of that of *C. rubi* var. *fervida*, and the venation is often, especially veins three, four, and five of the upperwing in the ♂s, marked by rather broad dark lines as if raised, differing from the narrower flatter lines seen in *C. rubi*. A marked character is that the head has a long ruddy fur, replacing all trace of the silver lines round the eyes so conspicuous in *C. rubi*. The androconial brand on the ♂ forewing is triangular, perhaps a shade broader than in *C. rubi*, but of only about half the length along the line of the veins, that it has in *C. rubi*, in which it is oval or fusiform. The club of the antenna is red or flesh-colour, all along the lower inner side, a colour confined in *C. rubi* to a few terminal joints of the club, and the same on all aspects of the antenna. There is rather a different shade of green on the underside, and the white line has quite a different character from that in *C. rubi*. It is narrow, but continuous; it is, in fact, usually broken by each vein, but looks continuous compared with *C. rubi*, in which the line breaks up into spots, rather than become narrow as in *C. avis*. Either really, or as an effect of its narrowness, it has a suggestion of being faintly tinted green. It is entirely without the dark scales along its inner margin that are so constant in *C. rubi*. The portion in each interneural space is curved. It occupies all the spaces on each wing, from the costa to the space

in front of vein two, but is bright towards the costa (space between six and seven), and fades towards the inner part of the wing. The row of spots in *C. rubi* is much more irregular. The first spot on the hindwing slopes inwards, in *C. rubi* it slopes outwards, giving the second spot the appearance of being displaced inwards in *C. rubi*, outwards in *C. avis*. The ♂ appendages have only slight differences. I have not examined sufficiently numerous specimens to be able to assert that these are constant.

“It specialises in its foodplant, instead of being quasi-omnivorous like *C. rubi*.

“Habitat, Southern France (Var, and Pyrénées-Orientales), Morocco (Tangier). The only specimen I have seen, not in my possession, is one in the Brit. Mus. Collection, ranged with *C. rubi* var. *fervida*, and labelled ‘Tangier, Elwes Coll.’”

My original description does not need much amplification, but one or two points deserve notice, perhaps the most important is in the lengths of the palpal joints, a reference to Plate XXI will show that in *C. avis* the second joint is rather longer and stouter than in *C. rubi*, but the last joint definitely shorter.

The white line on the underside is really often slightly tinted green, especially beneath the forewing; sometimes it is continuously a line, at others, and more usually, a little broken up. Sometimes it is nearly a straight (or curved) line. In other specimens, on the hindwing, the costal spot, for example, inclines inwards, the next three are nearly in line quite outside this, and the fifth and following spots are again further out. In *C. rubi*, the spots are always in a continuous chain, sometimes in a regular line (or curve), at others with some zigzag.

In *C. avis*, apart from some variation on the forewing, all the spots are present and the total variation is comparatively small. In *C. rubi*, as is well known, they vary to the greatest extent, as to some, more, or all being absent.

The general position of the line is much nearer the base of the wing than in *C. rubi*. In *C. avis* it is, for example, on the hindwing very near the end of the cell; in *C. rubi* it is much nearer half-way between the cell and the hind margin.

The red colour beneath the knob of the antenna strikes one as a novelty compared with the more familiar *C. rubi*, and one is inclined to assume that the black area in *C. rubi* is scaled. It is, however, the case that the scaled and

unscaled areas are almost identical in the two species. The unscaled area corresponds to the red area in *C. avis*. The rest of the antenna is of the same colour if the scaling be removed; this is also the case in *C. rubi*, the difference between the two antennae, denuded of scales, being the blackness in *C. rubi* of the black part of the unscaled portion (Plate XIV).

The face differs less than one at first supposes. *C. avis* has rather more and longer hairs, but the great difference is the absence of the silver lines of *rubi* (from which the genus is named), these scales being red in *C. avis*.

The brilliance of these lines in *C. rubi* makes the hairs curiously inconspicuous, an effect aided by their duller colour, which varies from grey (sometimes almost brown) to black (Plate XIV).

In regard to the dark margins to the white spots in *C. rubi*, it is worth noting that in the genus *Neolycaena*, there is a very similar row of white spots with very similar dark margins. Taking into account the very similar androconial brand, there is no doubt that had *Neolycaena* had a green underside (after all a really trivial difference), we should have considered the species to belong to *Callophrys*. Standinger places the *Neolycaenas* in *Thecla*, though he separates *rubi* under *Callophrys*. Curiously Bingham retains *Neolycaena* amongst the "Blues," although Bethune-Baker, so long ago as 1892, showed (in our Transactions) their true position. *Callophrys*, *Neolycaena*, and *Thestor* form a very natural tribe (*Thestoridi*). I would venture to predict that the larva of *Neolycaena* will be found to possess a honey-gland. I have noted the brand in *C. avis* as triangular, really it is polygonal and might almost as well be called circular. Its lower margin is rather angular. The relative measurements in the two species are; longitudinal, *i. e.* in line of veins, *C. rubi*, 1.7 mm.; *C. avis*, 1.2 mm.; transverse, *C. rubi*, 0.75 mm.; *C. avis*, 1.05 mm.

It will be seen on reference to my figures (Plate XVI), that the difference in the form of the brand is not so much due to a difference in the portion of the wing occupied by it, as to a marked difference in the arrangement of the veins underlying it—a difference not easy to describe but obvious on inspection. These figures are rough and diagrammatic, but are nevertheless sketched under camera, and may be trusted as correct on this point.

The androconia (Plate XVI) of both species are parallel-sided with rounded extremities, those of *C. avis* are apparently rather more loaded with pigment. There is, however, a very notable difference in form between them. Those of *C. avis* are short and broad, of *C. rubi* long and narrow, *i. e.* compared each with the other.

The following figures are the result of measuring thirteen scales of each, taken at random, just as they came. They are of course not so accurate as if a much larger number were taken, but are probably not far out, as they agree with one's impressions on looking over a larger number.

	Length in mm.		
	Average.	Greatest.	Least.
<i>C. rubi</i>	0·13	0·190	0·1
<i>C. avis</i>	0·11	0·154	0·1
	Width.		
<i>C. rubi</i>	0·0308	0·045	0·024
<i>C. avis</i>	0·0390	0·054	0·03

The relative measurement of the palpi (Plate XXI, fig. 1) in the two species is interesting, especially in view of Rambur's note on his Andalusian specimens of *C. rubi* (?).

The actual lengths of the three palpal joints in the two species are in millimetres.

	<i>C. avis.</i>	<i>C. rubi.</i>
First joint	0·57	0·60
Second joint	1·20	1·00
Third joint	0·48	0·60

The second joint is also slightly more robust in *C. avis*. In *C. rubi* its end is nearly transverse; in *C. avis* it is sloping, so that its upper margin has much the aspect of ending in a spine. In both, the end of the third joint looks truncate and has the well-known terminal tube.

The male ancillary appendages (Plate XX) are very similar, quite within limits that are exceeded by mere variation in many species, but we know that in several groups of Lycaenids, specific and even generic, differences are often very small.

In this case all the *C. rubi* examined absolutely agree

together, and the one *C. avis* I have mounted differs in several points from these.

The proximal ventral projection (saccus) is in *C. avis* broader but with straighter sides, and therefore sharper point, than it is in *C. rubi*. The dorsal hooks are at their bases suddenly bent rather than curved and are thicker, especially towards their ends; their tapering extremities being shorter in *C. avis* than in *C. rubi*. The exerted portion of the shaft of the aedoeagus is rather more slender. The dense portion of the clasps is very distinctly more long and slender in *C. avis* (as 7 to 6).

In the medio-dorsal line the proximal margin is a sharp angle in *C. avis*, an open arch in *C. rubi*, whilst the distal margin is narrower in *C. avis* and the denser chitinous elements more solidly knitted together.

The preparations I have made of the female abdomen (Plate XXI, fig. 2; Plate XXII) are far from being as satisfactory as I should like, but one or two points of difference between the two species, *C. avis* and *C. rubi*, are evident enough.

The long chitinous tube in the eighth segment (corresponding to the very long aedoeagus of the male Theclid), is narrower in *C. avis* (two specimens examined) especially towards its lower end, so that in *C. avis* it gradually increases in width from its lower end forwards. In *C. rubi* the narrowest part is about the middle, thence enlarging towards either end. The tube is also distinctly longer in *C. rubi* than in *C. avis*, though I have a specimen of *C. rubi* that approaches *C. avis* more nearly than the one photographed. The two remarkable spinous organs in the wall of the *bursa* seem to be nearly alike, viz. each with two long sharp spines; in *C. rubi* there seems to be much variation in the length of the second spine; in *C. avis* they are both equal, but an examination of further specimens may (or may not) show them to be as variable as in *C. rubi*. The reason for supposing they are *not* so variable in *C. avis* is, of course, that in other characters in which the two species differ, *C. rubi* is always the more variable.

I took my first specimen in the little range of hills between Hyères and Carquieranne; of these hills the best known is the *Colline des Oiseaux*, near Costebelle, and so, assuming this fly to be one of the birds for which that summit is famous, I have given it the specific name of *Avis*.

My interest at the time in *Callophrys rubi* was stimulated by Mr. Tutt's impending treatment of that insect in his "British Butterflies," in connection with which he expected me to supply him with various important observations. Possibly without this stimulus the specimen of *C. avis* would not have been taken. It puzzled me very much; I hardly thought it could be a distinct species, but there were almost greater difficulties in supposing it to be a hybrid with some other *Thecla* or an aberration of *C. rubi*.

The specimen is noted in Tutt's "British Butterflies" (vol. ix, p. 96) under the head of *C. rubi*, ζ var. *fervida*.

"A very remarkable example of this form, taken by Chapman at Hyères in April 1906, is very large, 36 mm.; has a very narrow and yet almost continuous white line on the underside of the wings; has the underside of the antennal club largely red, a character that appears to be very rare, judged by our long series, and we believe not before noticed by any lepidopterist."

The colour of the upper surface would lead to its being placed with *C. rubi* var. *fervida*, but no notices of *fervida* I have come across report specimens possessing the peculiar characters of *C. avis*, and the localisation of *C. avis* and its rarity even where it occurs make it unlikely that many specimens exist unrecognised in collections. Even in his great collection, where one would expect to find it, if anywhere, Mons. C. Oberthür tells me that he cannot detect one.

Rambur's note on *Thecla rubi* in his "Catalogue of the Lepidoptera of Andalusia" leaves on my mind little doubt that some, at least, of his specimens were *C. avis*. He says the specimens are distinguished "by the ochreous of the upper wings and by the continuity of the white line beneath the lower; the last joint of the palpi is also shorter." The last item at least is definite, and it is the case that this last joint is shorter in *C. avis* than in *C. rubi* (see *ante* and Plate XXI).

Staudinger's var. *suavcola* of *C. rubi* agrees with *C. avis* in its large size and in the want of tails. In all other respects it agrees with *C. rubi*. I have examined two specimens at the Brit. Mus., South Kensington, from Artrabad and Shahkuh, and one from M. Oberthür's collection, from Syria.

The last palpal joint is more like that of *C. rubi* than

of *C. avis*, and the green of the underside has a little of the tone that distinguishes *C. avis*, but a similar tone is not uncommon in *C. rubi*. The underside spots have the dark scales at their inner margins as in *C. rubi*. On the meagre amount of material examined, I do not feel at all positive that *suaveola* is not perhaps a species, distinct from *C. rubi*, as it certainly is from *C. avis*.

The var. *fervida* of *C. rubi*, with which I was at first inclined to agree with Mr. Tutt in placing my first odd specimen of *C. avis*, agrees with *C. avis* only in approaching its ruddy tint, I have seen no specimen reaching the rich tones of a really fine *C. avis*; and in a little approach also in many specimens in the tint of green on the underside—in all other respects it differs from *C. avis* as does ordinary *C. rubi*. It was the prevailing form of *C. rubi* at Amélie-les-Bains.

I have not met with any further reference to the species, except my own note on the capture of my second Hyères specimen in 1907, which appeared in "Ent. Record," vol. xix, p. 152, until I described the insect as a new species in the "Ent. Record," vol. xxi, p. 130 (see *ante*), and exhibited specimens at the Society's meeting on June 2nd last (Proc. 1909, p. xxix).

I was enabled to do this in consequence of having taken a few specimens in the Pyrénées-Orientales (at Amélie-les-Bains), and luckily observed a ♀ ovipositing, and thus succeeded in obtaining eggs, and have reared the insect, up to the present, of course, only so far as the pupal stage.

Since the description of the species was published Prof. Reverdin tells me he took a specimen some 20 kilometres east of Hyères, and I have seen a specimen in the collection of Mr. A. S. Tetley, of Scarborough, taken by Mr. Allan Rowntree at Bussaco, Portugal (within the old monastery precincts), on May 27th, 1904. The specimen is a ♀ of 34 mm. expanse, in fair condition, but sufficiently worn to have perhaps been some time on the wing. Still, the date seems later than one would expect, but the Atlantic side of the Peninsula probably does not warm up in spring so rapidly as the Mediterranean littoral.

The specimen is very interesting as showing a wider distribution of the species than merely the western end of the Mediterranean basin.

This Portuguese specimen led to my writing to my friend Prof. C. Mendes at São Fiel, asking him to look

over his series of *C. rubi* in search of any intrusive *C. avis*.

He writes me that he "has found one specimen taken by his colleague Prof. Tavares in May at Jerez. It is one of two specimens, of which one is *C. rubi*, the other *C. avis*, with the hindwings somewhat worn. The distinction is perfect. I have also examined more than twenty specimens from the neighbourhood (São Fiel), from Lisbon and from Algarve, all of which are *C. rubi*."

Spain can thus be added to the habitats of *C. avis*.

On October 26th, 1909, M. C. Oberthür wrote me that he had just received from Tunisia two specimens that appear to be *C. avis*, and later, after actual comparison, he tells me that they certainly are *C. avis* (2 ♂♂) from Ain-Draham (Kroumirie), Tunis.

Unfortunately, by the time I had "spotted" my butterfly at Amélie-les-Bains the weather became dull and unsettled, so that I can say little of its habits. It can fly strongly in good weather, but does not stray far from its proper habitat. It affects (for feeding probably) flowers of a species of *Euphorbia*, where it is sometimes accompanied by specimens of *C. rubi*. Owing to weather, I had no opportunity of seeing it orient itself in the sun as *C. rubi* does.

The butterfly I saw ovipositing on April 20th was laying her eggs on the flowers (?), calyx really, of *Coriaria myrtifolia*.* I found at this date that two ♀♀ that I had placed on *Cytisus spinosus* (or closely allied species), which, by their joint distribution, seemed to be the chief food-plant of *C. rubi* at Amélie, three days before, had laid only two eggs. They began to lay at once when given *Coriaria*. On April 30th an egg laid wild, hatched; eggs laid in confinement began to hatch on May 3rd.

The following are my notes of experiments on the food-plants of *C. rubi* and *C. avis*. They show that *C. rubi* would not touch, or only sparingly and ineffectually, the food-plant of *C. avis*. Whilst *C. avis* absolutely refused all the ordinary pabula of *C. rubi*.

May 26th. — Placed some newly-hatched larvae of *C. rubi*, parents taken amongst *Coriaria* at Vernet-les-Bains, on *Coriaria*, and found that they refused for 24

* The local botanists (Messrs. Raine, Powell, Jehandiez, etc.) say that *Coriaria myrtifolia* does not grow near Hyères, it follows that *C. avis* must there subsist on some alternative food-plant.

hours to touch it. When placed on *Ulex europaeus* flowers they at once settled down and soon began to feed.

Having done so twice before, I again placed a half-grown larva of *C. avis* on mixed flowers of *Ulex europaeus* and *Cytisus scoparius*, and another on flowers of *Cornus sanguinea*. Left for 24 hours the larvae on each occasion starved.

Larvae of *C. rubi*, newly hatched, placed on flowers of *Cornus sanguinea*, went for the open flowers and did some eating; next day, however, they had eaten very little, and were very restless, three of them being down on the stem; they became quite pacified and settled down when given blooms of *Ulex*.

Larvae of *C. rubi* placed on *Helianthemum* at once attacked the flower-buds and appeared to thrive on them; one then placed on *Erodium* attacked a flower-bud, but, that demolished, and there being no other, it and a second larva starved rather than touch the leaves or any other part of the plant. Larvae given buds of bramble, made deep holes in the buds, but after a time and after seeming to be quite at home, left them and seemed very discontented. First-instar larvae placed on *Coriaria* starved rather than eat it; last-stage larvae ate it sparingly, but in two days were smaller rather than larger, got on a little better for a day or two, but then were obviously doing so badly that they were restored to broom flowers.

C. avis refused any of the ordinary flowers loved by *rubi*, such as gorse, broom, *Spartium junceum*, etc.

I fed my young larva on the flowers, and they seemed somewhat indifferent what portion they ate, but as the male flowers rapidly become useless on the stamens bursting, I found them to take more especially to the female flowers, clearing out the immature fruits. When they were in their second instars I found them eating such portions of leaves as I had given them with the flowers, and on giving them leaves they seemed to prefer them to the now not too tender flowers (or rather fruits). Thereafter I fed them on leaves, and I owe many thanks to Monsieur Boixo, the "Roi du Canigou," for sending me supplies of leaves on which to feed my larvae after my return to England.

The last larva hatched on May 15th, and on May 18th the first larva is supposed to be in third instar.

In the first instar the larva is a greyish green, or even perhaps cinereous, but pale and in a sense colourless, the head black and the

hairs also, except just at emergence. The youngest larvae are now (May 18th) somewhat grown and are of a pale brownish tint, consisting, however, of the effect of the sparse black hairs, with a skin in two colours. The black hairs are the long dorsal ones, the, nearly as long, lateral ones, are pale or colourless.

The ground-colour is a light ochreous yellow with a trace of green and the reddish-brown markings are a light or diluted maroon. The prothoracic plate is dark but not black, the anal plate darkly tinted but pale by comparison with the prothoracic plate. The reddish markings are a line down each side of the dorsum, not quite central to the dorsal flange but rather to its inner side, and slightly interrupted at the incisions. A similar subspiracular line, leaving the dark dots of the spiracles on a pale line or area above it. Above the spiracles a line or band broadest at the front margin of each segment, leaving another pale area between this and the subdorsal line, somewhat triangular on each segment, from being broadest at its posterior margin, complementary to the red line beneath it, and centrally in this pale area a triangular red mark, with its posterior margin not quite coincident with the posterior margin of the segment. On dorsal view the prothorax often looks dark (pale indian ink) from the black head retracted into it. The larva is of the usual onisciform shape, about 2 mm. long and 0.7 mm. broad, fairly equal in width, but perhaps slightly tapering backwards, the ends little more than semicircles. On end view, the lateral flanges are marked, but the dorsal ones are the rather sharp margins of a flat dorsal area.

In the second instar the larva is at first reddish in general tone, about 3.5 mm. long. The ground-colour is a green slightly toned with yellowish brown, but the greater part of the surface is occupied by pale reddish brown, viz. two brown lines (or bands) on each side of the dorsal line (left of the yellowish green ground-colour) and just inside tubercles I and II. The broad brown flange line below the spiracles, along the prominent bosses of IV and V forming the flange. The spiracular level is of pale ground-colour, but above it is a darker area, higher on the front of each segment, leaving a pale area narrow in front and broader behind, above it containing a darker spot in its centre.

As it grows in this instar it becomes wholly green, the change in size and colour being so remarkable that I had some difficulty in satisfying myself that an unobserved moult had not taken place. The length reaches 4.5 to 5.0 mm. The previous markings are just indicated in darker green. The head is dark except the mouth parts and just above the labrum.

In the third instar (in which were still a few on June 3rd) the

larva attains 12.0 mm. when stretched in walking with head extended; the width about 3.0 mm., and of head about 0.6 mm. The head black, except where the vertex is usually within prothorax, labrum whitish. The rest of the larva is wholly of a transparent green, except a very narrow lateral line, yellow, and the prothoracic plate of a purplish pink, with a faint pale median line. The spiracles are darker dots, apparently very narrow rings of deep brown.

When about to moult the larva spins a few threads to surrounding leaves as well as a silken pad.

In the last instar when full grown (Plates XV, XVII, XVIII) the larva when active attains a length of about 20 mm., but when resting or sulky only some 15 or 16 mm., but is then some 5.5 mm. wide, and 5 mm. high; short and thick, thickest about first and second abdominal segments.

The larva is of a uniform transparent green, with a yellow lateral line and a brilliant red (purplish pink) prothoracic plate. The depression of the prothoracic plate is conspicuous, lying deeply under mesothorax with the front of the prothorax rising above it.

The broad red stripe across the prothorax, and the uniformity of all the larvae in the light transparent green colour, broken only by the plate and by the thin lateral line, render the larvae conspicuously different from any other I have seen.

The red stripe is like nearly all colouring in Lycaenid larva, a little way below the cuticle, and though one supposes at first it is a colouring of the prothoracic plate, this is not so, as it extends widely to each side beyond the plate, almost right across the prothorax. Only one larva varies from this, in having a broad lateral rusty red band, obscuring the yellow lateral line, which seems deeply buried, but has some of the rusty tinting at the incisions. The rusty tint is superficial and involves the whole flange practically up to the spiracles. The prothorax is ruddy tinted and there is a slight tint on the dorsum of the seventh abdominal segment.

I copy the above as it appears in my notes, but further notes show that this larva was in the first stage of the change of colour that is undergone when the larva is preparing to search for a place for pupation.

The larva never goes anywhere without making a silken path and often quite a pad, on the leaf it is eating. When recently moulted into the last instar, there is quite a ruddy halo due to the closeness of the reddish hairs. When the larva is full-fed the hairs become so far separated as to be hardly visible.

On June 7th, I noted that on each of the past three

days some larvae have assumed a darker tint, gradually deepening to a dark olive green, almost black, as compared with the bright light green of the feeding larvae. They have the yellow lateral line changed into a red, almost brick-red one, looking deeply sunk in the tissues.

In looking for a place to pupate, the larvae of *C. avis* were quite disconsolate when I provided them with some loose earth with a little loose rubbish on top, such as I had found suited *C. rubi* admirably. With such provision *C. rubi* goes out of sight and pupates, if not strictly underground, still beneath the loose surface material. On providing *C. avis* with bits of stick, leaves, paper and so on, I found that after a period of wandering, that is common to so many larvae that have to travel often some distance in search of a puparium, they settled down, on some object an inch or two above the surface, sometimes in a little hollow, sometimes between two surfaces such as two dead leaves, etc., and here did some slight spinning, amongst which some few threads were usually disposed, though often separately, as a girth, and there was also a more or less distinct anal pad. Not one example went into even the most superficial rubbish.

In comparing the larvae of *C. avis* and *C. rubi*, we find that in *C. rubi*, in the first instar when fairly grown the larva has the white patches below the dorsal line broad, very white (not ochreous) and without any brown patch in it on each segment as in *C. avis*.

In the second instar (June 2nd) it looks not unlike *C. avis* in the same instar, but is a little greyer; as it grows it loses all likeness to first-stage larva, at first rather striking, and becomes green, but with very marked darker and lighter green on pattern of the brown and white, and reaches a length of 6 mm.

In the third instar (June 8th) (Plate XXXII), it is green with a very marked pale dorsomedian line, dorsal flange line and oblique stripes, these are quite yellow in some specimens, pale green in others, but seldom quite as bright as the yellow lateral line. The hairs are black, not quite so in some, but without the rich ruddy tint they have in *avis* in the later instars. The prothoracic plate is clearly seen brownish-black, the colouring being confined to the plate itself. Length 10-12 mm., according to how much extended.

The larvae appear frequently to eat the cast skins and apparently the heads with them, if one may judge by the

difficulty of finding the cast heads. A circumstance that adds much difficulty to counting the moults.

When the young (first instar) larva of *C. rubi* attains its colour, which it does a shade earlier than does *C. avis*, the colours are not pale ochreous green and brown, but a white that is almost that of porcelain and a more ochreous, less red, brown. The dorsal brown lines are broader. The white below it looks broader and perhaps is, but its greater effect is more due to its whiteness, and to its wanting the brown patch on each segment, the sub-dorsal hairs (III?) are visible with a hand lens easily, being black as are the lateral (flange) hairs (colourless in *avis*).

In the last instar, the uniform green tint of *C. avis* contrasts in its light transparent tone with that of *C. rubi* (Plate XV), in the same stage, and in its uniformity, quite unbroken by any trace of the oblique stripes, which are always more or less present in *C. rubi*. Any appearance of stripes in *C. avis* is the effect of the illumination on the irregularities of the "upholstering" of the sides.

C. avis has its yellow lateral line and its red mark across the prothorax, but no other colouring, and each larva is like every other without any variation. *C. rubi* always has the oblique stripes, sometimes as a different tone of green, sometimes as more or less bright yellow, and sometimes further emphasised by some red margins, making a very handsome and gaudy larva. I did not meet with this brilliant form this year, so have not got it figured. An essential point, moreover, is not merely the presence of these stripes in some form, but the great range of variation that the larva presents, as compared with the uniform *C. avis*. It never has any approach to the red thoracic mark, and may even seem almost without a thoracic plate; the mark here in *C. rubi* being merely the very small central brownish portion of the plate, without any further colouring.

Another marked difference between the two species in the last instar, is the much greater dorsal swelling of the segments and the correspondingly greater depth of the incisions dorsally in *C. rubi*. So that on lateral view, *C. rubi* has a very serrate dorsal outline, as compared with the tolerably smooth aspect of *C. avis*, the latter might, in fact, when compared with *C. rubi*, almost be taken for a Chrysophanid like *C. rutilus*.

Callophrys avis has a pupa (Plate XIX) very similar to that of *C. rubi*, a little larger and stouter, length 10 mm. ; measurement does not, however, show that it is any stouter. In this living pupa the pale (brown) ground-colour seems more easily seen and more abundant than on *rubi*, and the two tints brown and black seem more distinctly separated. The abdominal dorsum distinctly looks paler than in *rubi*, owing to the greater amount of brown ; this may easily, however, be a matter of racial or even individual variation.

The spiracles (abdominal) are more obvious in *C. avis*, being nearly white on a very small brown area, whilst in *C. rubi* they are brown on a (usually) rather larger brown area. The hair and surface sculpturing present no differences to be detected in the living pupa. The cremaster appears to possess a much larger number of hooks, corresponding with the more frequent occurrence of a practicable girdle.

On August 26th, 1909, I overhauled pupae of *C. avis* and *C. rubi*. Those of *C. avis* have wings very black and opaque ; those of *rubi* are brown, in some, suggesting that there was clear fluid under a brown skin, but in others (to my surprise) the brown was paler and opaque suggesting wing-development going on, and in these the eye-spots were also blackening. The eyes and wings of *C. avis* were too black and opaque to make it probable similar changes, if going on, would be visible. Kept several advancing *rubi* up in warm room to see if they would force, but without effect after several weeks. With hardly an exception the *C. rubi* were all on the earth at the bottom of the jars, or even in if not below it, and without an adhesion to anything. The *C. avis* were equally away from the ground, an inch or more, and with some attachment in many cases, and in one or two with something like a distinct girth. The decay of material to which they were attached made this impossible to verify in probably a good proportion of cases in which it had existed.

The egg (Plate XXIII, *et seq.*) is laid in the flowers of *Coriaria myrtifolia*, those I saw laid naturally on the calyx of the male flower, and providing them with similar material I found those in captivity did the same, varying a little by laying occasionally on the stamens, as well as on the short flower-stalks, and even on the stems at the base of the flowering racemes.

In no case was an egg attached by anything but its lower surface, and though put to some extent out of

sight was not often wedged into any sort of crevice, differing therein much from the egg of *C. rubi*, which is almost as a rule pushed in between two surfaces, and adheres by its top to the upper one, only a little less than by its base.

The egg is extremely like that of *C. rubi* (Plate XXIII); it may be a shade larger, 0.7 mm. in diameter, or sometimes rather wider. In colour it is like *C. rubi*, green, and in some respects nearly white, but on the whole it is less green and has usually a whiter appearance. The sculpturing is almost alike. The actual egg is in fact green, but the superficial adventitious coating is white, and differs from that in *C. rubi* in consisting not merely of the columns and ribs, but has also a slight layer over the bottom of the cells that seems to be wanting in *C. rubi*.

In photographing the micropyles of the two species, Mr. Clark found such a difference in the nature of this adventitious coating, that he made various preparations and quite a research to elucidate the differences. He notes that "*C. rubi* has apparently a single coat, which is quite transparent when mounted in glycerine (Farrant's medium), and shows the network structure of cells perfectly, either in this way or when mounted as a dry object." On the other hand, "*C. avis* has apparently two coats, the outer one bears the sculpture of network, is granular, especially under pressure, and separable from the inner coat; the latter being transparent and devoid of any special structure or trace of cell formation. The sculpture is fairly well seen mounted as a dry specimen, whilst in fluid (Farrant's) it becomes a granular amorphous mass." He also notes that "the basal portion of these eggs is of simple cells" (*i. e.* without adventitious coat), "which terminate abruptly when the side of the egg is reached." This is the case in all Lycaenid eggs I have examined, though the cellular structure of the base is often so faint as to require some looking for. In *Callophrys* it is very distinct. Mr. Clark also notes that "the micropylar structure is best seen when mounted and pressed quite flat in Farrant's medium. I could detect no 'pores' as is the case in some eggs."

The adventitious coat of Lycaenid eggs, as a rule, breaks up into an amorphous pulp when treated with any medium such as alcohol, benzole, glycerine, etc., so that it is useless to try to preserve or observe them

in any way but as dry objects. Mr. Clark's observation on *C. avis* eggs shows that it follows this usual rule, and in glycerine it is at once seen that the eggshell has two layers—the true shell which is persistent and the white coating which disintegrates. His remarkable discovery is that in the egg of *C. rubi* the adventitious coat differs entirely from that of *C. avis*, in some chemical or other quality, as to be uninjured by Farrant's medium, and acts as if the true eggshell and the coating were one homogeneous layer. One would hardly expect so considerable a difference to exist between two so closely allied species.

I ought perhaps to say, though it is carrying coals to Newcastle, that I do not report Mr. Clark's discovery without having repeated and verified it myself. As perhaps having some connection with this point, I may observe that an egg of *C. avis* is easily obtained, pure and simple, an egg of *C. rubi* has nearly always attached to it some hairs or filaments belonging to the plant on which it was laid (see Plate XXIII). A corollary no doubt of the circumstance that the egg of *C. avis* is attached merely by its base, whilst that of *C. rubi* adheres also, if possible, by some part of the upper surface. This is probably associated with a different composition of the white coating, a difference revealed in another way by Mr. Clark's experiment.

The eggshell of *C. rubi* comes out little if at all injured after successive treatment by water, by alcohol, and by benzole, that of *C. avis* is decidedly damaged both by alcohol and by benzole, but by water it is much altered, and the water around it exhibits a multitude of minute colourless spindle-shaped bodies of about 0.001 mm. in length.

In all cases, the base, which has no coating, is unaffected, and retains its network unaltered.

Plates XXV and XXVII show the eggshell of *C. rubi* with the mesh of ribs arranged in triangles, so that they would obviously fall into hexagons but for the exigencies of a curved surface. The columns are end on, and so do not show their height. The double outline of the ribs is, no doubt, an optical effect in the dry shell of the empty egg; it is seen also in *C. avis* and in other Lycaenid eggs. Fig. 2 is a portion of the eggshell of *C. avis* dry, and not pressed.

In Plates XXVI and XXVII we have three specimens of

the eggshell of *C. avis* showing the micropylar area, and showing also the effect of pressure in Farrant's medium in destroying the meshwork of the surrounding area, and in the example of *C. rubi* (Plate XXVII, fig. 1) it appears unaltered by this treatment, except a little distortion by pressure and some blurring due to the high magnification ($\times 350$) making its thickness too great for being in focus throughout. Though Mr. Clark says there are no pores visible, I think I detect them in the preparations from which Plate XXVII, fig. 2 (*avis*) and same Plate, fig. 1 (*rubi*) are taken. They have probably become more evident by lapse of time, as often happens to objects in Farrant's medium. In Plate XXVI, fig. 2, there are five cells to the micropylar rosette (four and six respectively in the other two figures of *C. avis*), and apparently five pores; but it is also the case that in the specimen of *C. rubi* (Plate XXVII, fig. 1), which has seven cells to the rosette, there are equally five pores, arranged most regularly in the centre. The breaking down of the adventitious coat, especially in Plate XXVI, fig. 2, and Plate XXVII, fig. 2, in *C. avis* makes the distinction between the cells of the micropylar area (without *adventitia*) and those surrounding it very distinct, and shows that two rows with a few odd ones surround the rosette. Though the demarcation is not so fully demonstrated in the preparation of *C. rubi*, it is nevertheless very obvious, and more so in the actual preparation than in the photograph, that there are about four rows of cells round the rosette in that species, and that as the cells do not differ much in size, the area (or "depression") is larger in *C. rubi* than in *C. avis*. In dealing with the details of hairs, lenticles, etc., of the larva at different stages, I may refer to my notes on *C. rubi* in Tutt's "British Lepidoptera," vol. ix, p. 104 *et seq.*, which are fairly full, and also to the photographs by Mr. F. N. Clark, accompanying this paper, from specimens I have prepared. This will save much verbosity.

In comparing the larvae in the first instar, *C. avis* (Plate XXVIII) seems smaller and more delicate (though the egg seemed, if anything, larger), certainly it has a smaller head, and certain hairs, present in *C. rubi* (Plate XXIX), are wanting and others less developed. The most notable of the absent hairs are those (III?) between the subdorsal lenticles and the spiracle. Of these *C. rubi* has two in each of the abdominal segments one to seven. They are

well-developed hairs, nearly half as long as the long ones of tubercle I. These are wanting in *C. avis* absolutely in all of nearly a dozen specimens examined, except in one that has a hair here on the first and second abdominal segments, and on one or two others.

Another hair well developed in *C. rubi*, absent in *C. avis*, is one in front of the long dorsal hair (I?) on seventh abdominal segment. The short hair in front of I on the abdominal segment is little more than half the size in *C. avis* that it is in *C. rubi*.

Plate XXVIII is taken from the specimen of *C. avis* in which the supra spiracular hairs (III?) happen in a few cases to be present.

The prothoracic plate has four short hairs along the front margin in *C. rubi* that are wanting in *C. avis*. This is in accordance with the general stronger development of hairs in *C. rubi*.

In the first instar there is no trace of a honey-gland.

In the second instar (Plate XXX) less difference between the panoply of hairs is discoverable than in the first, between the two species. *C. rubi* (Plate XXXI) is, however, rather more strongly haired. The longest hairs are about 0.37 mm. long in *C. avis*, and few reach this; the corresponding figure for *C. rubi* is 0.42 mm. The two photographs (Plates XXX and XXXI) give a not very unfair indication of the difference between the two, although it is much emphasised by accidental differences in preparing the specimens.

In these photographs, as in several of the others, it is necessary to point out that in Plate XXXI the prothoracic plate is properly displayed, in Plate XXX its posterior margin is bent under.

In both species there is in this instar a first indication of the honey-gland on seventh abdominal segment, a slight failure of the ordinary hairs appear, and there are three or four lenticles in line, marking the posterior lip of the opening, which I suppose is always present, though I have only managed so to speak to "glimpse" it in two or three specimens. Each pad of the prolegs and claspers, which in the first instar had two hooks, now has five—two longer and three shorter.

To complete the view of these crochets it may be noted that in both species eleven seems to be the number of hooks to each pad in the third instar, eleven on one pad

and nine on the other being not uncommon, a larger number, twelve or thirteen, is rare; they alternate large and small, with small ones at each end, sometimes the end of each series is smaller than the middle ones.

In the last instar they are much more numerous but much alike and variable in the same way in the two species; twenty-one to twenty-three is about the average; one may find twenty-three on one pad and seventeen on the other, and as many as twenty-five occur—sometimes the front, sometimes the posterior, pad has the fewer crochets. They are alternately longer and shorter, but the longer set often varies again into longer and shorter.

In the third instar (Plate XXXII) the hairs are again just appreciably longer and stronger in *C. rubi* (Plate XXXIII). The honey-gland (Plate XXXVI, fig. 2) is now quite distinct in both species by a flight of lenticles along both lips and by the recession of the principal hairs.

In the last (fourth) instar, the honey-gland (Plate XXXVII) is very obvious; a space is made for it by the loss of the longer dorsal hairs. The appearance shown in Plate XXXVII, fig. 1, of four circles right down in the gland, is one I am familiar with in the larvae of "Blues," but what precisely they represent, functionally or homologically, I do not know.

I suspect them, however, to represent the two pairs of dorsal hairs (I and II) changed into glandular structures.

The hairs at all stages (if we except the curving in the first stage) are simple and straight and armed with fine spicules; in the last stage, however, these have so dwindled that it may be said they have disappeared, traces of them are more easily detected in *C. rubi* than in *C. avis*.

At all stages the bases of the hairs are spread out and divided by lines, so as to take the floral aspect they have in many other Theclids.

I have already noted the extra hairs that *C. rubi* has on the prothoracic plate in the first instar. In the later instars (Plates XXXIV, XXXV, and XXXVI) the hairs and lenticles of the prothoracic plate vary so much that it is difficult to find two individuals with precisely the same dispositions, so that the differences one may note in a few specimens between *C. avis* and *C. rubi* are more probably individual than specific. The special angular hair does

not declare itself in the first instar, but afterwards is present equally in both species and is well seen in the photographs of those of the second and third instars (Plates XXXIV and XXXV).

In the last instar (Plate XXXVI) they are not so easily found, as the outer angle of the plate on which they are is not at all chitinised, and is, in fact, like the rest of the skin. I believe I am correct in saying that the red mark in *C. avis* goes far beyond the plate, but I may not have made enough allowance for this non-chitinisation of its lateral wings. In Plate XXXVI, fig. 1, the special hairs would be about half-an-inch outside the picture.

So far as I know the existence of a honey-gland in the THESTORIDI has not been previously reported. It certainly escaped the notice of both Mr. Tutt and myself, both in his researches in the literature of the species and my (I fear rather perfunctory) observations of the living larvae. There is no mention of it in Tutt's account of *Cullophrys rubi* in his "British Lepidoptera," vol. ix.

I may add that I have searched for indication of the fans or scent(?) glands of the eighth abdominal segment and have not succeeded in discovering any; I incline to believe they do not exist, still, if they are rudimentary, they might be present and easily elude me.

So far I have had no empty pupa shell of *C. avis* to mount. The only one I have mounted had to be cleaned by some maceration in potash, which has had the effect of softening the hairs and rendering them useless for descriptive purposes. In other respects I believe the specimen is trustworthy. I believe the hairs are practically identical with those of *C. rubi*, as the result of such observations as can be made on the living pupa. Nor in other respects have I been able to seize any decided differences. Both species, for example, appear to have structural provision for movement between the fifth and sixth abdominal segments. Both have the peculiarity that I have only discovered in Theclids of having not only the eighth but also the seventh abdominal spiracle merely cicatricial. In neither is there any scar of the honey-gland, present in not a few "Blues."

The general characters will be better gathered from the few photographs reproduced than from long descriptions (Plates XIX, XXXVIII, and XLIII).

P.S.—A few further notes will be found in Proceedings

under date March 16, 1910. M. Oberthür figures and describes *C. aris* in Fasc. IV of his "*Études de Lepidopterologie Comparée*," which will be published about the same time as this. Prof. C. Mendes has a note on the species in *Brotéria* 1910, p. 67.

EXPLANATION OF PLATES XIV—XLIII.

[See *Explanation facing the PLATES.*]